AN ANALYTICAL APPROACH OF DISCRIMINATING BASKETBALLERS IN THEIR SELECTED POSITIONS ON THE BASIS OF PREDETERMINED ANTHROPOMETRIC, BIO-MOTOR AND SKILL RELATED PARAMETERS.

SHORT SYNOPSIS

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CERTIFICATE

I hereby declare that the short synopsis "**An analytical approach of discriminating basketballers in their selected positions on the basis of predetermined anthropometric, bio-motor and skill related parameters**" being submitted in partial fulfillment of the requirement for the degree of Doctor of Philosophy under Lakshmibai national Institute of Physical Education NERC, during academic year 2022-23.

It is Bonafide record of original work carried out under the supervision of Dr. Hem Chandra Joshi and has not been submitted in full or part to any other university or institute for a degree or diploma. Further, it is certified that the short synopsis is plagiarism-free and the proof has been submitted**.**

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Abstract

Basketball performance is heavily influenced by the interplay of anthropometric, bio-motor, and skill-related attributes, which vary significantly across player positions. This study seeks to develop a discriminant model for classifying national-level male basketball players (*N*=90; aged 20–25) into three key positions point guards, shooting guards, and centers by analyzing predetermined variables, including anthropometric (height, weight, arm span, leg length, palm span), bio-motor (agility, speed, endurance, leg explosiveness, shoulder strength), and skill-related (shooting, dribbling, passing, rebounding) parameters. Using standardized tests such as the SEMO Agility Test, 12-minute Cooper Run, and Johnson Dribble Test, data will be collected and analyzed through multiple discriminant analysis to identify dominant predictors for positional differentiation. The anticipated outcomes aim to reveal position-specific discriminators (e.g., height for centers, agility for guards), thereby providing coaches with practical tools for talent identification, tailored training, and optimized team composition. By bridging the gap between empirical research and practical application, this study offers a transformative framework for evidence-based player selection and development in competitive basketball, particularly within India's evolving sports ecosystem. The findings could redefine positional coaching strategies, emphasizing data-driven decision-making to enhance on-court performance.

Keywords: Anthropometric, Bio-motor, point guard, shooting, guard, center, discriminant model.

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1 INTRODUCTION

"The fusion of sports and research creates a powerful force for social change, pushing boundaries, challenging norms, and inspiring generations to pursue greatness on and off the field." **- Nelson Mandela.**

Basketball is a highly dynamic sport that demands more than just speed and skill it also involves a constant transition between offense and defense, making it both physically and mentally challenging (Maric, 2013). While much attention is often given to technical abilities like shooting, passing, dribbling, and rebounding, one crucial factor that often receives less emphasis is the significance of playing positions. Every player is assigned a role on the court such as point guard, shooting guard, small forward, power forward, or center based on a unique blend of their physical traits, athletic abilities, and technical competencies. Each position carries its own set of responsibilities and demands, all of which are essential for achieving team success. A well-rounded basketball team isn't just about having skilled individuals; it's about strategically balancing the roster so that each player's strengths complement those of their teammates. For coaches and scouts, having a deep understanding of these positional roles is key. This knowledge enables them to make more thoughtful decisions regarding talent recruitment, player development, and game strategy decisions that can ultimately shape the performance and cohesion of the entire team

At the elite level of basketball, a team's success often hinges on the ability to recruit players whose skills not only align with the tactical demands of the game but also complement the specific requirements of their assigned positions. (Kleiner, 1998). In recent years, the integration of statistical modelling into basketball has become an essential tool for evaluating player performance. These models consider a wide spectrum of variables—ranging from anthropometric measurements to bio-motor capabilities and skill-based competencies—to provide coaches and analysts with meaningful insights into each player's strengths and limitations. One such approach, discriminant analysis, allows researchers to develop predictive models that can determine the most suitable playing position for an athlete based on their unique physical and technical attributes. Player positioning holds a pivotal role in shaping team strategy and performance outcomes. A team's overall success depends not just on individual talent, but on how effectively each player contributes through their specific role on the court. The application of data-driven models and advanced analytics enhances a team's ability to make informed decisions regarding player deployment, training focus, and tactical planning. In basketball, executing the right play often begins with the correct use of positional roles. The five primary positions point guard, shooting guard, small forward, power forward, and center each serve a distinct function. The point guard typically acts as the playmaker, orchestrating offensive movement and facilitating ball distribution. The shooting guard specializes in scoring opportunities, particularly through mid-range and long-distance shots, often finding strategic positions in the frontcourt to execute these plays effectively.

In the dynamic world of basketball, the power forward position holds a pivotal role, combining strength, athleticism, and versatility. The power forward, often referred to as the "4,". The power forward position is characterized by a blend of physical strength and athletic versatility, enabling players to dominate near the basket while also contributing effectively in transition play. Individuals in this role are expected to possess a well-rounded skill set that includes strong post-up techniques, effective rebounding, and the capability to score from mid-range or beyond the arc. Their combination of size and technical ability makes them central figures on both offense and defense. Power forwards often take responsibility for setting screens, securing second-chance opportunities through offensive rebounds, and offering defensive reinforcement in the paint. This position demands not only physicality and coordination but also a high level of basketball intelligence to adapt to various game situations. In essence, the power forward represents a strategic balance between raw power and refined skill.

The small forward, often referred to as the "three" or the "wing," occupies a versatile role on the basketball court, positioned between the shooting guard and power forward. This player is typically known for their adaptability, as they are expected to contribute across multiple aspects of the game. Key responsibilities include scoring, defending, and supporting rebounding efforts. Small forwards are usually among the team's top scorers, often ranked second or third in point production, and are expected to possess a reliable perimeter shot in addition to the ability to penetrate the defence and create opportunities at the rim.

Offensively, they serve as dynamic scorers who can stretch the floor or drive to the basket, while also facilitating plays for teammates. Defensively, small forwards are tasked with guarding agile perimeter players usually the opposing team's shooting guard or small forward requiring excellent lateral quickness, spatial awareness, and the ability to switch effectively on screens. Moreover, they play a supporting role in team defence by contesting shots, intercepting passes, and securing rebounds. The position demands a well-rounded skill set that combines athleticism, shooting accuracy, and defensive tenacity.

Centers in basketball are the tall players who stand close to the basket. They have two main jobs: scoring points near the hoop and protecting the basket on defense. They use their height to grab rebounds and block shots. Centers are crucial for strong defense and creating scoring chances near the basket. They balance the team by working well with other players and are essential for dominating the inside game. Basketball strategy naturally positions athletes with greater height and physical strength in center roles, as their proximity to the basket enhances rebounding efficiency. This tactical alignment implies a measurable relationship between players' court assignments and their statistical contributions during gameplay. (Sampaio, 2007)

Basketball is a sport that demands the development of advanced motor abilities, including coordination, agility, speed, endurance, quick reflexes, and explosive strength (Sevim, 1997). A player's success on the court is often determined by their ability to execute essential skills such as accurate shooting, precise passing, controlled dribbling, effective defense, and efficient rebounding. These skill-related variables are not only vital for

individual performance but are also critical for designing targeted and effective training programs.

An effective basketball team is built upon the diverse skill sets of its players, with essential abilities such as shooting, passing, dribbling, defending, rebounding, and assisting serving as the cornerstones of successful play. Of these, shooting stands out as a key determinant of individual impact—players who can consistently and accurately score add immense value to the team's offensive strength. Passing, on the other hand, is crucial for maintaining ball movement, setting up scoring opportunities, and fostering seamless team coordination.

Dribbling helps players control the ball skillfully, opening up scoring chances for themselves and their team. Defensively, players need to read the opponent's actions, block shots, and force turnovers. Rebounding is key for securing the ball, stopping the other team from scoring, and creating new offensive plays. Additionally, assisting means setting up teammates for easy baskets with smart passes. Recognizing how these skills and roles work together is vital to understanding basketball's dynamic and team-oriented gameplay.

In basketball, every position demands unique abilities. The relationship between shooting, passing, dribbling, defense, rebounding, and assists is key to how the game flows. While all players benefit from accurate shooting, passing enhances teamwork and sets up scoring chances. Dribbling allows players to break through defenses and create plays. On defense, players must read opponents, block shots, and force turnovers. Rebounding helps control the ball, stops the other team from scoring, and creates extra offensive opportunities. Assists involve setting up teammates with smart passes to score. Understanding how these skills connect is essential for grasping the depth of each position and the game as a whole. In conclusion, measuring and understanding specific basketball skill-related variables such as shooting, passing, dribbling, defending, rebounding, and assisting is essential for the development of a comprehensive and effective training program. These skills are critical for any basketball player and can determine their success on the court. Therefore, coaches and trainers must pay close attention to these variables to help players reach their full potential and succeed in the highly competitive world of basketball.

Bio-motor abilities like speed, endurance, flexibility, and coordination play a crucial role in athletic performance. These skills enable athletes to execute fundamental movements such as running, jumping, and throwing effectively and consistently under different conditions. As a result, motor fitness serves as the key indicator for assessing overall physical fitness, as it reflects how well the body performs in various physical tasks. (Bookwalter, 1952). Different sports require different bio-motor abilities (physical qualities), and athletes must follow specialized training programs including general, sport-specific, and competitive exercises to develop these skills. For instance, strength can be built by working against resistance, whether from body weight, a training partner, medicine balls, or weights like barbells.

Each athlete has a distinct profile when it comes to bio-motor abilities. Since athletic performance depends heavily on these physical traits, coaches must know how to train and

assess them using proper evaluation methods. Only highly skilled athletes tend to possess all necessary bio-motor abilities at an optimal level, allowing them to perform at their best. (Uppal, 2009).

A player's bio-motor abilities significantly influence their performance and skill execution in basketball, both during games and training. Experts believe that a basketball player's success largely depends on their physical fitness, including key attributes like speed, flexibility, power, strength, agility, and endurance. High-level skill performance is directly linked to an individual's bio-motor fitness—the better their physical conditioning, the more effectively they can execute advanced techniques. (Debnath, 2001).

Anthropometric measurements (body size and proportions) play a crucial role in distinguishing between different basketball positions. These physical characteristics should be carefully evaluated during player selection, as they significantly impact positional suitability and performance potential. (Pottyondy, 2021) Anthropometric measurements are crucial for evaluating basketball players' physical characteristics and distinguishing between different positions. Metrics such as height, weight, wingspan, and body composition offer critical insights into the distinct physical demands of each role. For example, centers and power forwards typically rely on superior height and reach, while guards excel with speed and agility. By incorporating this data, coaches and scouts can make more strategic decisions in player selection and position assignments. This scientific approach not only refines team composition but also maximizes competitive potential by aligning players' innate physical advantages with positional requirements.

2 LITERATURE REVIEW

Puranik.G, Prabhu.G (2019) A study was conducted on 600 male basketball players from various regions of Karnataka to examine the discriminatory potential of anthropometric and physiological variables among guards, forwards, and centers. The research aimed to identify position-specific physical characteristics, with participants aged 12–32 years, evenly distributed across guards (N=200), forwards (N=200), and centers (N=200). Anthropometric measurements included height, weight, sitting height, arm span, four width measurements, three girth measurements, and five skinfold thicknesses. Physiological variables assessed were vital capacity and blood pressure. All anthropometric data were standardized using Ross and Wilson's (1975) unisex human model (Z-scores). Stepwise discriminant analysis was employed to determine group classification. Key discriminators included height, stature-adjusted forearm girth, supra-spinal skinfold, medial calf skinfold, mid-thigh skinfold, triceps skinfold, leg length, bi-ileorectal width, peak expiratory flow, and femur width. Function 1 yielded significant discriminative power (Wilk's $\lambda = 0.623$, canonical correlation = 0.509, $\chi^2 = 271.703$, $p < 0.05$). Function 2 also showed significance (Wilk's $\lambda = 0.853$, canonical

correlation = 0.383, $\chi^2 = 93.86$, $p < 0.05$). The model correctly classified 61.2% of players, with height and stature-adjusted mid-thigh skinfolds contributing substantially to both functions.

Drinkwater, (2008) A review of existing literature reveals that fitness testing research in court sports like basketball is notably limited compared to field sports or individual disciplines such as running and cycling. Basketball performance hinges on a multifaceted combination of factors, including player size, fitness levels, sport-specific skills, tactical execution, and psychological traits. The modern game places significant emphasis on physical attributes, with coaches and players prioritizing body size and fitness. A player's stature often dictates their positional role, while the sport's high-intensity, intermittent demands necessitate superior conditioning. To assess these physical requirements, coaches and sport scientists employ a series of sport-specific tests to evaluate body composition, aerobic capacity, and power. These assessments help monitor athlete development, gauge training program efficacy, and aid in talent selection. Recent advances in sports science have established reference values to benchmark individual progress and compare differences between players. Emerging statistical approaches, such as magnitude-based inferences, offer more practical interpretations of fitness data, making results more actionable for coaches and athletes.

Optimizing test selection, implementation, and data interpretation can significantly enhance the utility of fitness testing in elite basketball programs. The Drinkwater et al. study contributes to this field by providing reference values for player fitness and body size, along with practical methods to evaluate intra-athlete changes and inter-athlete differences beyond traditional null-hypothesis testing.

Hoare,(2000) Talent identification programs have traditionally focused on individual sports with discrete physical and physiological characteristics. Research on performance prediction in team sports remains limited. This study examined anthropometric and physiological characteristics of 248 junior basketball players (125 male, 123 female) competing in the 1998 Australian Under-16 Championships. Experienced coaches evaluated player performance during the tournament, enabling comparisons across positions and between top-performing ('Best') versus other ('Rest') players. Key findings revealed position-specific differences in anthropometric measures for both genders, along with variations in speed and agility across certain positions. The Best players demonstrated superior anthropometric and physiological attributes compared to Rest players in both male and female cohorts. Regression analysis showed test variables explained 41.3% of performance variance in females and 38.3% in males. Z-score analysis indicated strong agreement between test results and coach rankings for four of five female positions and two of five male positions.

While anthropometric and physiological profiling can inform selection processes in junior basketball, the study confirms that performance determinants are inherently multi-factorial, extending beyond physical attributes alone.

Trininik,Drizdar(1999) This study examined differences among basketball players from national teams participating in the 1996 Atlanta Olympic Games, analyzing three positional groups: guards (positions 1-2), forwards (position 3), and centers (positions 4-5). The research compared players using body height, body mass, and 13 standardized performance indicators derived from in-game statistics. Discriminant analysis demonstrated that anthropometric characteristics effectively distinguish players by position, thereby defining their specific in-game roles and responsibilities. These positional differences became evident through distinct performance patterns: centers and guards showed significant differences from forwards in defensive/offensive rebounds and blocked shots, while guards were differentiated by assists compared to forwards and centers. Additionally, forwards and guards outperformed centers in three-point field goals. The results clearly illustrate how anthropometric profiles shape positional specialization, which subsequently manifests through measurable differences in game performance metrics.

(Gál-Pottyondy et al., 2021) Basketball ranks among the world's most popular team sports, requiring diverse athletic skills that serve as key indicators of player talent. Systematic testing of these abilities assists trainers and scouts in making informed selection decisions across age groups, competitive levels, and playing positions. However, limited scientific evidence exists regarding the relationship between field test results and actual match performance metrics. This systematic review aimed to consolidate existing research on physical field tests and anthropometric measurements in basketball, examining potential correlations with in-game statistics across various positions and skill levels.
Paper's methodology involved comprehensive searches across three electronic databases (PubMed, Google Scholar, Sport Discus), with article quality assessed using the CASP checklist. Analysis of 39 included studies revealed that agility, speed, and vertical jump test results emerge as critical performance indicators for basketball players. Anthropometric measurements proved particularly significant for differentiating between playing positions, underscoring their importance in player selection processes. Additionally, maturity status demonstrated considerable influence in U-18 team evaluations. The findings suggest that elite players can be distinguished by their reactive power and unplanned agility capabilities, which appear to most significantly impact game outcomes among players of similar competitive levels.

(Erol et al., 2016) Conducted a study in which Physical attributes and physiological performance play crucial roles in basketball success, yet these characteristics remain under-evaluated among young players. This study compared anthropometric, physiological, and motor characteristics across three fundamental playing positions (center, forward, guard) and examined their interrelationships. The research sample comprised 30 elite male basketball players aged 13-14 years selected as candidates for the Turkish U15 national team, with 10 players representing each position. Comprehensive anthropometric measurements and physical fitness tests were conducted to assess player characteristics. Results revealed significant differences ($p < .05$) among positions for multiple parameters: body height,

weight, BMI, arm length, leg length, hand length, upper body length, arm span, hand width, fat-free mass, and anaerobic power. The study establishes valuable reference profiles for elite young male basketball players across positions. Notably, guards demonstrated significantly smaller stature and lower body weight compared to forwards and centers, with these positional differences proving more pronounced than documented in previous research. These findings highlight the importance of position-specific physical development in youth basketball programs and provide objective criteria for player evaluation and selection processes.

(Dawood & Hadi, 2013) conducted a study which states that developing motor coordination through scientifically-designed, age-appropriate training exercises is crucial for enhancing basketball skills in players. As a fundamental motor capacity, coordination significantly influences skill execution accuracy, movement fluidity, velocity control, and decision-making during gameplay. This study addresses the concerning lack of emphasis some coaches place on motor coordination development, particularly for young athletes. The research specifically examines the impact of targeted exercises on improving motor coordination in junior basketball players. Using an experimental methodology, the study involved 16 players aged 13-15 years from Al-Hillah Sports Club. Results demonstrated that incorporating specialized coordination exercises into training regimens significantly enhances motor coordination development. The experimental group, which followed the specific exercise program, showed greater improvement in motor coordination compared to the control group that maintained standard coaching practices. These findings highlight the effectiveness of structured, scientifically-based coordination training and underscore its importance in youth basketball development programs. The study provides compelling evidence for coaches to prioritize motor coordination exercises when training junior players, as these targeted interventions yield measurable improvements in this critical athletic capacity.

(Maric, 2013) conducted a study which investigated the relationship between motor abilities and player efficiency in young basketball players (cadets) from five first-league clubs in Herzegovina. A comprehensive assessment was conducted using 12 tests of basic motor abilities and 5 specific basketball efficiency tests on a sample of 83 players. Canonical correlation analysis revealed two significant linear combinations explaining the relationship between fundamental motor skills and basketball-specific abilities. The first combination demonstrated the positive influence of general motor factors - particularly explosive jumping power, arm movement speed, upper-body static strength, and coordination - on key basketball skills including movement efficiency, overarm throw power, shooting/passing accuracy, and ball handling. The second combination highlighted the contribution of precision and balance abilities to passing/shooting accuracy and ball control.

Regression analysis further established that specific motor abilities significantly predict game performance, with ball handling emerging as the most influential factor for player quality. This was followed by shooting precision, passing accuracy, and overarm throw power in

descending order of importance. The findings clearly indicate that ball control capability represents the primary determinant of player effectiveness in cadet basketball, with shooting accuracy and passing precision constituting secondary essential skills. These results provide valuable insights for coaches regarding the most critical abilities to prioritize in youth basketball development programs.

3 DESCRIPTIONS OF BROAD AREA

Basketball:

Basketball is a competitive team sport featuring two squads, typically composed of five members each, that face off within a defined rectangular playing area. The central goal involves strategically propelling the ball through an elevated hoop while engaging in coordinated offensive and defensive maneuvers.

Anthropometry

The measurement of human body and its parts. With standardized techniques. (Kansal, 2012).

Leg Length

Leg length is defined as the distance between greater trochanter to the outside edge of the foot.

Palm Length

Hand length is defined as the distance from the tip of the third finger to the base of the thumb (most proximal carpel bone)."

Bio-motor

Bio-motor abilities encompass the essential movement-based competencies required to execute physical tasks effectively. The term originates from "bio" (life) and "motor" (movement), collectively describing the physiological foundations of athletic performance. These include foundational capacities like muscular strength, explosive power, cardiovascular endurance, rapid speed, precise coordination, joint flexibility, reactive agility, and postural stability. (Introduction to biomotor abilities, 2023)

Arm-span

Arm span, the distance from fingertip to fingertip when arms are fully extended horizontally.

Agility:

Agility is defined as “one’s controlled ability to change body position and direction rapidly and accurately” (Kansal, 2012)

4 OBJECTIVES OF THE STUDY

PROBLEM STATEMENT

Basketball positions demand distinct skill sets and physical attributes - point guards require playmaking abilities, shooting guards need scoring proficiency, and centers rely on rebounding and shot-blocking capabilities. However, there remains a lack of empirical evidence identifying the specific anthropometric, bio-motor, and skill-related parameters that objectively differentiate players by position. This knowledge gap creates challenges in player development, position-specific training, and talent identification programs. The absence of a scientific classification model based on measurable characteristics may lead to suboptimal player positioning and training approaches. Therefore, this study aims to develop a discriminant model that can accurately classify basketball players according to their optimal playing positions using selected anthropometric, physiological, and skill performance parameters. The findings will provide coaches and talent scouts with evidence-based criteria for position-specific player development and team composition strategies.

RESEARCH OBJECTIVES

1. To identify the key variables for discriminating basketballers in their playing position from selected predetermined anthropometric parameters.
2. To determine the significant bio-motor variables that differentiate basketball players in their playing positions, based on factors such as agility, reaction ability, speed, shoulder strength, leg explosiveness and endurance.
3. To investigate the skill-related variables that are most influential in distinguishing basketball players across different playing positions, including shooting accuracy, dribbling skills, passing ability, and rebounding ability.
4. To develop a discriminant model on the basis of anthropometric, bio-motor and skill related parameters.

Limitations

1. The study could not account for dietary habits, lifestyle differences, or individual training routines that may have influenced results.
2. Lack of advanced tools restricted precise measurement of key physiological and performance parameters.
3. No specialized strategies were used to boost participant engagement during testing, potentially affecting performance outcomes.

Delimitations

1. The study will be delimited to minimum Ninety [N=90] national level basketball players with at least 5 years of playing experience in India.
2. The age of the subjects will be 20-25 years and they will be Male, senior level players.
3. The present study will further be delimited to players for discriminating three different playing ability i.e., Point guards, Centers and Shooting guards used in basketball match.
4. The study will be further delimited to following predetermined variables of Anthropometric, Bio motor and skill related variables to discriminate basketball players in selected positions:

a. Anthropometric Variables

i. Height
ii. Weight
iii. Arm Length
iv. Leg Length
v. Palm Span
vi. Arm Span

b. Bio motor Variables

i. Agility
ii. Strength (Shoulder)
iii. Cardiovascular Endurance
iv. Speed
v. Leg Explosiveness

c. Skill Related Variables

i. Shooting
ii. Dribbling
iii. Passing
iv. Rebounding

Hypothesis

It is hypothesized that basketball players performing in different positional roles specifically point guard, shooting guard, and center exhibit meaningful differences in selected anthropometric, bio-motor, and skill-based characteristics. These differences are expected to enable the development of a statistically valid discriminant function model capable of accurately categorizing players according to their respective positions.

5 RESEARCH METHODOLOGY

The present study will adopt an analytical and descriptive research design to explore the extent to which predetermined anthropometric, bio-motor, and skill-related variables can be used to differentiate basketball players based on their playing positions. This design is appropriate for examining relationships among multiple variables and for developing a discriminant model that classifies players into specific positional categories.

Selection of Subjects

A total of ninety (N=90) national-level male basketball players, aged between 20 and 25 years, will be purposively selected for the study. The sample will be evenly distributed across three key playing positions:

- Point Guards (n = 30)
- Shooting Guards (n = 30)
- Centers (n = 30)

Participants will be selected based on their official designation and performance records at the national level. The subjects to be selected for study will be sourced from various institutions that will be approached are mentioned:

- Services Basketball Teams
- LNIPE Gwalior
- LNIPE, NERC, Guwahati
- Odisha Basketball Association

Prior to data collection, each player will be clearly informed about the purpose and scope of the research. To ensure ethical transparency and voluntary participation, a subject consent form will be provided. Participants will also have the opportunity to raise questions or express concerns, creating an open and respectful research environment.

Selection of Variables

In line with the objectives of the study, a structured battery of variables has been identified across three major domains:

1. **Anthropometric Variables**

These are physical body measurements known to influence positional specialization in basketball:

- Height
- Weight
- Arm Length
- Leg Length
- Palm Span
- Arm Span

2. **Bio motor Variables**

These variables capture key components of athletic performance essential for basketball:

- Agility
- Shoulder Strength
- Cardiovascular Endurance
- Speed
- Leg Explosiveness

3. **Skill Related Variables**

These variables represent core technical abilities in basketball:

- Shooting Accuracy
- Dribbling Skill
- Passing Ability
- Rebounding Efficiency

CRITERION MEASURES

ANTHROPOMETRIC VARIABLES

S.No.	Variable	Test	Criterion Measure
1	**Height**	Stadiometer	Height will be measured in centimetres
2	**Weight**	Weighing Machine	Weight will be measured in Kilograms
3	**Arm Length**	Steel Tape	The readings will be recorded to the 0.1 cm
4	**Leg Length**	Steel Tape	The readings will be recorded in 0.1 cm
5	**Palm Span**	Steel Tape	The readings will be recorded in 0.1 cm
6	**Arm Span**	Steel Tape	The readings will be recorded in 0.1 cm

BIO MOTOR VARIABLES

S. No	Variables	Test	Criterion measure
1	**Agility**	SEMO Agility Test	Time is recorded in seconds
2	**Shoulder Strength**	Medicine Ball Throw	Distance is measured in meters
3	**Leg Explosiveness**	Philip JCR Vertical Jump Test	Height is recoded in inches
4	**Speed**	40 Yard Dash	Time is recorded in seconds
5	**Cardiovascular endurance**	12 Min COOPER RUN	Maximum distance is measured under

			12 mins

SKILL RELATED VARIABLES

S No	Variables	Test	Criterion Measure
1	**Shooting**	Johnson Field Goal Speed Test	Points made under 30 seconds
2	**Dribbling**	Johnson Basketball Dribble Test	Points made under 30 seconds is counted.
3	**Passing**	AAHPERD Basketball Passing Test	Passing on targets under 30 seconds
4	**Rebounding**	Harrison Basketball test component Rebound	Points Rebound in 30 seconds

Procedure for Collection of Data

All measurements will be conducted on a standard basketball court and training facility approved for national-level testing. Participants will undergo testing under uniform conditions to maintain standardization and reliability of data. Each test will be preceded by a brief warm-up session to ensure safety and optimal performance.
Testing tools will include standardized physical and performance tests which includes Anthropometric, Bio-motor and Skill Testing, detailed procedure is given as follows: -

ANTHROPOMETRIC MEASUREMENTS

1. Name of the variables: Height

Objective: To measure maximum height of the player

Equipment required: Stadiometer

Procedure: The individual is instructed to stand barefoot on a flat horizontal surface with their back against a wall, ensuring heels, shoulder blades, and head maintain contact. They must extend their body fully while keeping both heels grounded. The head position is verified to align with the Frankfort Horizontal (FH) plane by directing the subject to focus on a fixed object positioned at eye level in front of them. The examiner then ensures horizontal alignment between the tragion (ear notch) and infraorbital (lower eye socket) landmarks. (Kansal, 2012)

Scoring: The height of the subjects will be measured in centimeter scale 'cms'

2. Name of the variable: Weight

Objective: To measure the body weight of the subject

Equipment required: Weighing Machine

Procedure: A mechanical weighing apparatus featuring an adjustable baseplate (circular or rectangular) is utilized for measurement. Participants are instructed to remove footwear and outer attire, retaining only undergarments. The individual assumes an upright posture on the device's measuring surface, ensuring symmetric weight distribution between both lower extremities.

Scoring: The weight of the subjects will be measured in 'Kilograms' 'kgs'.

3. Name of the variables: Linear measurements Arm Length, Leg Length, Palm Span, Shoulder width, Wing Span

Objective: To measure all the linear measurements mentioned in the variable

Equipment required: Will be measured with the flexible steel measuring tape, Measurement will be recorded to the nearest half cm.

Procedure: To take anthropometric measurements of the arm, leg, palm, shoulder, and wing span length using a measuring tape, the following procedure can be followed. Begin by ensuring that the subject stands upright in a relaxed posture, with bear arms and legs.

For arm length measurement, locate the acromion process (bony prominence on the shoulder) Record the linear span between the acromion process (shoulder's bony prominence) and the distal end of the middle digit, with the participant's upper limb fully abducted. The measuring

tape must maintain continuous contact with the arm's anatomical curvature during this assessment.

To measure leg length, locate the anterior superior iliac spine (bony prominence on the front of the hip) and the lateral malleolus (bony prominence on the outer ankle). Measure the distance between these two points along the lateral side of the leg, keeping the tape in contact with the skin.

For palm measurement, measure the widest part of the subject's dominant hand, typically across the metacarpophalangeal joints, using the measuring tape.

To measure shoulder width, locate the acromion processes on both shoulders. With the subject standing naturally, measure the distance between these two points across the back, ensuring the tape is parallel to the ground.

for arm span length, have the subject stand with arms extended straight out to the sides. Record the maximum span between the distal ends of both middle digits while maintaining full upper limb extension along the dorsal surface of the back.

Scoring: The measurements will be noted in 'centimeters' and 'inches' wherever needed.

BIO-MOTOR VARIABLES

1. Name of the variables: Agility

Objective: This evaluation protocol assesses multi-directional agility capacity through anterior, lateral, and posterior locomotor tasks. The gender-neutral assessment protocol is validated for all adolescents regardless of sex.

Equipment required: A stopwatch for plastic cones 9 x 9 base having 12 inches height or any suitable alternative substitute object, and the basketball court or any smooth area measuring 12 x 19.

Procedure: The agility test consists of several key steps. It begins with the subject positioned outside the marked rectangle, facing away from the free throw line. Upon the signal, they slide and step to the right, then backpedal to the inner corner of cone number 3. Next, they perform a forward sprint from just outside the 19-inch mark line to cone number one, followed by a quick direction change and backward run to cone number 4. From there, they sprint to cone number 2, and finally, execute a left sidestep to reach the finish line.

The stopwatch is used to record the time as both feet cross the finish line, assessing the subject's agility and speed.

Scoring: Participants complete two timed attempts, with each trial's duration recorded to a precision of 0.1 seconds. The final score corresponds to the fastest attempt, determined by selecting the lowest value from both trials

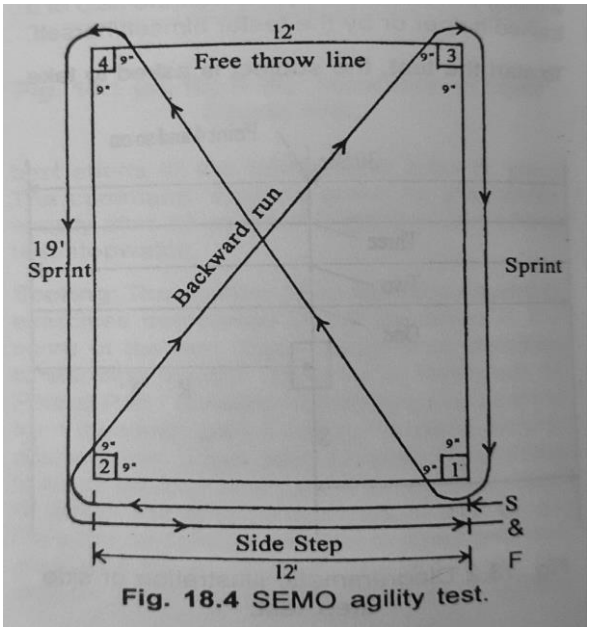


Fig. 18.4 SEMO agility test.

2. Name of the variables: Cardiovascular Endurance

Objective: to measure the cardiovascular endurance of the subjects.

Equipment required: Stopwatch, copy-pen, availability of track**.**

Procedure: The 12-minute Cooper run test involves instructing participants to run or jog as far as they can within a 12-minute time limit. After explaining the test, participants warm up before starting. They then run at a self-selected pace on a measured track or course while observers track their distance covered. After the 12 minutes, participants cool down and the total distance covered is recorded. The recorded distance serves as an indicator of cardiovascular endurance and can be compared to normative data. Safety precautions, clear instructions, and encouragement throughout the test are essential to ensure accurate results and participant well-being.

3. Name of the variables: Shoulder strength

Objective: To measure the strength of the shoulder

Equipment required: Chair, rope, chalk powder or tape, 3 kg medicine ball.

Procedure: Participants first observe a standardized demonstration of the seated medicine ball throw protocol. Each individual assumes a seated position while firmly gripping the

medicine ball, positioning it against the chest with hands beneath the chin. An assistant provides posterior support via a stabilization harness to restrict forward torso movement during the throwing motion. Two attempts are permitted, with the superior result (maximum distance achieved) retained as the final score.

Scoring: All distance measurements will be documented using the metric system (meters).

4. **Name of the variables**: Speed (40 yard dash)

Objective: to measure the maximum speed of the subject

Equipment required: Area of desired length. Preferably on an athletic track, playground, or football field, with a mark starting line and a finish line, Two stopwatches.

Procedure: Participants in the sprint test follow a set of guidelines to ensure accurate and consistent results. They can position themselves anywhere behind the starting line before the start signal is given. Once the "go" command is given, participants start running as fast as possible towards the finish line. It is important to gradually slow down only after crossing the finish line and to warm up before the sprint test. For timing purposes, a separate person with a stopwatch is required to accurately record each participant's sprint time at the finish line. The start signal for the sprint test is given as "ready, steady, go" to ensure it is audible to both participants and timers. Timers start their stopwatches when the participants start their sprints and stop them as soon as the participants cross the finish line. Sprint times are recorded with precision to 0.01 seconds. Only one trial is allowed, and participants should restart the sprint if they start before the command or fail to start quickly at the command.

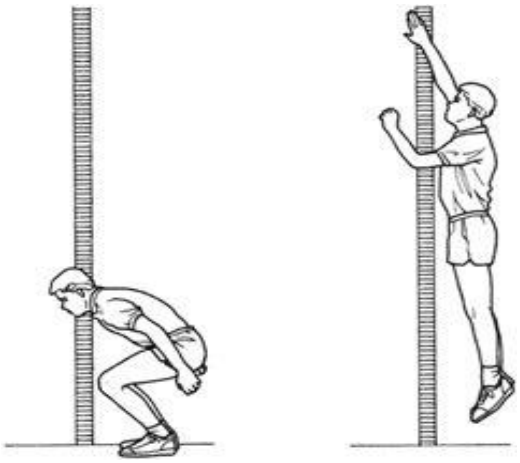
5. **Name of the variables**: Leg Explosiveness

Objective: to measure the leg explosiveness of the subject

Equipment required: wall marking, chalk Powder.

Procedure: To measure the vertical jump height, participants follow specific steps. They start by standing facing the board with an upright posture. Using chalk powder, the fingertips of the dominant hand are marked. Participants then raise their marked fingertips to the highest point on the backboard without lifting their heels to determine their maximum reach. Next, a vertical jump is performed, and the maximal height reached is marked on the wall. During the jump, participants bend their knees, swing their arms, and take a good jump without running or hopping. Depending on the protocol, participants may be given 3 to 5 attempts to achieve their best performance. The best performance out of the given trials is considered for analysis and recording purposes.

Scoring: The test score is derived from the peak vertical displacement between static reach and maximum jump height across all attempts. While converting to mechanical work (foot-pound measurements) requires multiplying this displacement by the participant's mass, most practitioners standardize scoring using the raw vertical distance. This mass-independent metric remains the preferred evaluation criterion in testing protocols. (Philip, 1947)



SKILL RELATED VARIABLES

1. **Name of the variables:** Shooting

Objective: To measure the shooting under pressure of time**.**

Equipment required: Basketball hoop, stopwatch.

Procedure: To conduct the field goal shooting test, the examiner positions themselves in any position under the basket. The examinee's objective is to make as many baskets as possible within a 30-second time limit. This test assesses the examinee's ability to make consecutive field goals quickly while being under time pressure.

Scoring: The number of successful baskets made in 30 seconds determines the score.

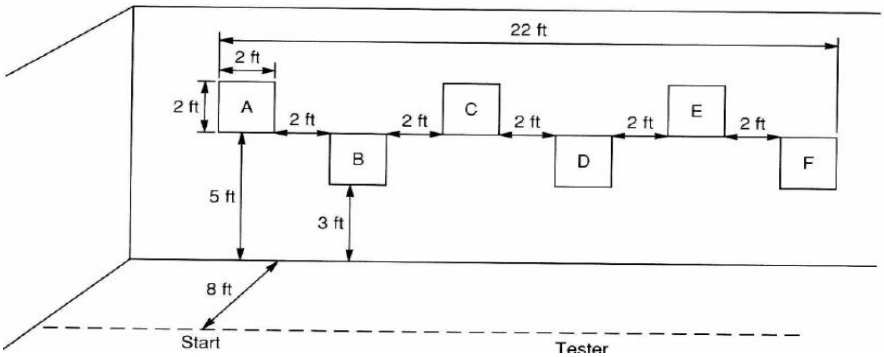
2. **Name of the variables:** AAHPERD basketball Passing Test item.

Objective: To measure the passing ability of the subject while moving.

Equipment required: An inflated basketball, Wall, marking tapes.

Procedure: The purpose of this test is to evaluate basketball passing and ball recovery skills while in motion. The wall setup includes six squares, measuring 2 feet each, with the lower side alternating between 3 feet and 5 feet from the floor. The examinee stands 8 feet away from the wall and performs three 30-second trials. During each trial, the examinee passes the ball to the first target in front, recovers the ball on the rebound while moving towards the next target, all while remaining behind the 8 feet restraining line. This passing and recovery process is repeated for each target.

Scoring: points scored in 30 seconds.



3. Name of the variables: Rebounding

Objective: To test the ability of rebounding in the pressure of time.

Equipment required: backboard, a standard inflated basketball

Procedure: In this test, the student takes a position near the backboard and tosses the ball towards it. As the ball rebounds off the backboard, the student jumps, catches the ball, and returns it to the backboard while still in the air. If unable to do so in the air, the student can

catch the ball, return to the floor, and toss it again. Each time the ball successfully hits the backboard; one point is counted. Two trials of 30 seconds each are conducted, and the better score between the two trials is recorded**.**

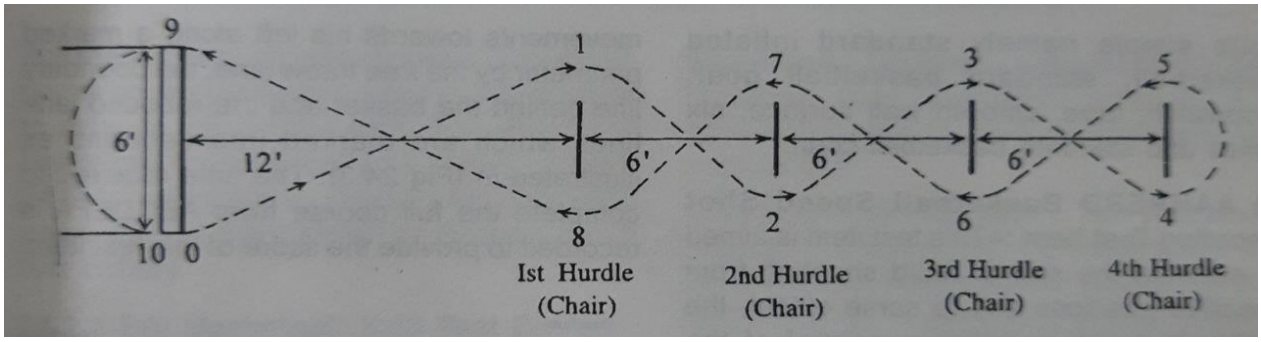
Scoring: Points scored in 30 seconds.

4. Name of the variables: Johnson Basketball Dribble Test.

Objective: To measure the dribbling ability and agility under pressure of time**.**

Equipment required: 4 chairs, chalks/marking tapes, measurement tape.

Procedure: The assessment protocol requires the participant to navigate a predefined obstacle course while maintaining continuous dribbling for 30 seconds. Markers are positioned linearly at 6-foot intervals, with the initial cone placed 12 feet from the starting position. The task initiates from the baseline, requiring the athlete to execute serpentine ball-handling around each marker. The drill mandates a directional reversal at the fourth obstacle, located 30 feet from the origin point, before completing the timed evaluation.



Scoring: Participants earn one point for each obstacle successfully navigated during the drill. The final marker's dual-sided structure, combined with the boundary line demarcating two distinct zones, awards two additional points one for crossing each zone threshold

6 STATISTICAL METHOD

Initially, descriptive statistics will be used to summarize and present the key characteristics of the sample. The statistical analysis will compute central tendency (mean), variability (standard deviation, SEM), and distribution shape (skewness, kurtosis) to evaluate data

dispersion and patterns within the selectedanthropometric, bio-motor, and skill-related variables. These indicators will provide an essential overview of how the players differ within and across their playing positions.

To achieve the primary goal of the study identifying the most influential variables in position-based classification and developing a predictive model Multiple Discriminant Function Analysis (DFA) will be applied. This technique will allow for the determination of which combination of variables best differentiates basketball players according to their designated roles: point guard, shooting guard, or center. DFA will also be used to construct a classification model capable of accurately assigning individual players to their correct playing position based on the identified predictors.

The discriminant analysis methodology rigorously adheres to fundamental statistical prerequisites, including the validation of multivariate normal distribution across predictor variables and homogeneity of variance-covariance structures between defined groups. These assumptions ensure valid classification accuracy and model reliability and absence of multicollinearity will be carefully examined before proceeding with the analysis. Ensuring these assumptions are met is essential for maintaining the validity and reliability of the model.

All statistical analyses will utilize a predetermined alpha threshold of $p < 0.05$, maintaining 95% confidence in the reliability of the derived outcomes.

All data will be analysed using IBM SPSS 26 statistical software, which provides robust tools for both descriptive and multivariate analysis. The software will facilitate accurate computation, interpretation, and graphical representation of the results.

7 EXPECTED OUTCOMES

Based on the reviewed literature and preliminary observations, this study anticipates developing a discriminant model capable of accurately classifying basketball players into three distinct positional categories **point guards, shooting guards, and centers** using a combination of **anthropometric, bio-motor, and skill-related parameters**. The model is expected to:

1. **Identify Key Discriminators**: Reveal which variables (e.g., height for centers, agility for guards) most strongly differentiate players by position.
2. **Validate Position-Specific Traits**: Confirm whether existing selection criteria (e.g., height dominance in centers) hold statistical significance or if overlooked factors (e.g., reactive rebounding time) play a decisive role.
3. **Provide Practical Utility**: Offer coaches and scouts a **data-driven framework** for:
    - **Talent identification** (assigning positions early in player development),
    - **Customized training** (tailoring drills to position-specific demands),
    - **Team composition strategies** (addressing gaps in roster construction).

REFERENCES

B, G. P. (2019). A study on position wise differences in anthropometric and physiological variables of basketball players. *International Journal of Physiology, Nutrition and Physical Education , 4*, 191-195.

Bookwalter. (1952). The Relationship of Body, Size and Shape of Physical Performance.

Dawood, H. (2013). Effect of Specific Exercises to develop motor coordination for junior basketball players 13-15 yrs. *international Journal of Advanced Sport Sciences Research*, 207-213.

Debnath, P. (2001). *A study to investigate selected physical, physiological, anthropometric and psychological variables as predictors of performance in basketball*. Retrieved from Shodhganga: http://hdl.handle.net/10603/2814

Drinkwater, P. (2008). Design and Interpretation of anthropometric and fitness testing of basketball platers. *sports med*, 565-578.

Erol, E. (2014). General Anthropometric and Selected Motor Skills of Elite Young Male Basketball Players According to Position on the Court of Players. *Journal of atheletic performance and nutrition*. Retrieved from http://hdl.handle.net/11616/56921

Harrison, E. R. (1970). A test to measure basketball ability for boys. Microform Publications. College of Health, Physical Education and Recreation.

Hoare. (2000). Predicting Success in Junior Elite Basketball Players . *Journal of science and medicine in sports*, 291-405.

Kansal, D. K. (2012). Test measurement and evaluation. Sports and Spiritual Science publication.

Kleiner, I. (1998). How to coach teams in business: the wooden way. *Management Research News*, 9-12.

Maric, K. (2013). Relations between Basic and Specific Motor Abilities and Player Quality of Young Basketball players. *Coll. Antropol.*, 55-60.

Nelson, F. B. (1965). *Hey Nelson Reaction Timer instruction leaflet.* Lafayette.

Philip, B. (1947). THE JCR TEST. Research Quarterly.

Pottyondy, P. (2021). Field Testing Protocols for Talent Identification and development in basketball. *MDPI.*

Sampaio, M. J. (2007). Discriminant analysis of game-related statistics between basketball guards, forwards and centres in three professional leagues. *European Journal of Sport Science*, 173-178. Retrieved from http://dx.doi.org/10.1080/17461390600676200

Sevim. (1997). Basketball: Technical and Tactical training.

Trininik, D. (1999). ANALYSIS OF DIFFERENCES BETWEEN GUARDS, FORWARDS AND CENTRES BASED ON SOMEANTHROPOMETRIC CHARACTERISTICS AND INDICATORS OF PLAYING PERFORMANCE IN BASKET. *kineziologija*, 28-34.

Uppal, A. (2009). *Science of Sports Training.* New Delhi, India: Publishers of Books on Physical Education & Sports .

(2023). Retrieved from Introduction to biomotor abilities: https://www.integratedperformance.institute/introduction-to-biomotor-abilities/